LIQUID PROCESSING DEVICE INCLUDING GAS TRAP, AND SYSTEM AND METHOD

FIELD

The present teachings relate to fluid handling assemblies, systems, and devices, and methods for using such assemblies, systems, and devices. More particularly, the present teachings relate to microfluidic fluid handling assemblies, systems, and devices, and methods for manipulating, processing, and otherwise altering small amounts of liquids and liquid samples.

BACKGROUND

Fluid processing devices are useful for manipulating small amounts of liquids. There continues to exist a need for a fluid processing device that enables controlled fluid flow through a processing pathway of the device. A need further exists for a reliable and easily actuatable device, and a system for processing the device, that together can efficiently process a small amount of liquid.

SUMMARY

According to various embodiments, the present teachings provide a fluid processing device that can include a substrate having a top surface and a bottom surface, a sample-containment feature at least partially defined by the substrate and having an inlet portion and an outlet portion, and a reservoir in fluid communication with the sample-containment feature and having a distal end portion that includes a closed end. The reservoir can extend away from the outlet portion of the sample-containment feature and can be arranged closer to the inlet portion of the sample-containment feature than to the outlet portion.

According to various embodiments, the present teachings provide a system that can include a fluid processing device having the features described above, a platen having an axis of rotation and which is capable of being rotated about the axis of rotation, and a holder capable of holding or securing the fluid processing device to the platen.

According to various embodiments, the present teachings provide a fluid processing device that can include a substrate having a top surface and a bottom surface, first and second sample-containment features formed in the substrate, a valve disposed in fluid communication with and between the first and second sample-containment features, an elongated reservoir formed in the substrate, having a closed end, and extending in a direction away from the first and second sample-containment features, and wherein the first sample-containment feature is arranged in fluid communication with the elongated reservoir.

According to various embodiments, the present teachings provide a system that includes a fluid processing device as set forth herein, and further including a platen having an axis of rotation and which is capable of being rotated about the axis of rotation. The system can include a holder capable of holding or securing the device to the platen. The system can include a heater for heating the device and/or the platen.

According to various embodiments, the present teachings provide a method that includes providing a fluid processing device including a sample-containment feature and a reservoir in fluid communication with the sample-containment feature wherein the sample-containment feature includes an inlet portion and an outlet portion, and spinning the microfluidic device to force liquid through the inlet portion and into the sample-containment feature. The method can further include trapping a gas, for example, air, in the reservoir as the gas is displaced by the liquid in the sample-containment feature, for example, as occurs when the sample-containment feature is loaded or filled with the liquid.

According to various embodiments, the present teachings provide a method that includes providing a fluid processing device including a sample-containment feature having an outlet portion, and a reservoir in fluid communication with the sample-containment feature, providing a liquid in the sample-containment feature, providing a gas in the reservoir, and spinning the device to force the liquid out of the sample-containment region and through the outlet portion.

Additional features and advantages of various embodiments will be set forth in part in the description that follows, and in part will be apparent from the description, or may be learned by practicing of various embodiments. The objectives and other advantages of various embodiments will be realized and attained by means of the elements and combinations described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a microfluidic device and a valve-deforming device, in operative alignment and according to various embodiments;

FIG. **2** is an enlarged, perspective view of a microfluidic device according to various embodiments;

FIG. **3** is a cross-section through the microfluidic device of FIG. **2** according to various embodiments;

FIG. **4** is an enlarged, perspective view of region **4** taken from FIG. **2**;

FIG. **5** is a cross-sectional end view of a deformable valve taken through line **5-5** of FIG. **4**, including an opening deformer, subsequent to an opening operation on the deformable valve;

FIG. **6** illustrates an enlarged, perspective view of a depression formed in a substrate of a microfluidic device by way of an opening blade deformer according to various embodiments;

FIG. **7** is a top plan view of region B' of FIG. **4**, showing a fluid communication between a loading channel and a sample-containment feature, and a gas trap or reservoir filled with a gas after a liquid transfer procedure for loading liquid into the sample-containment feature;

FIG. **8** is a top plan view of an alternative embodiment of region B' of FIG. **4**, showing two fluid communications formed between the loading channel and the sample-containment feature and the gas trap filled with gas after the liquid has been transferred into the sample-containment feature;

FIG. **9** is a top plan view of the device shown in FIG. **8** but after a deformer has deformed displaceable material and formed an interruption in each of the two fluid communications;

FIG. **10** is a top plan view of an embodiment of region B' taken from FIG. **4** and after two downstream fluid communications are formed extending from an outlet portion of the loaded sample-containment feature; and

FIG. **11** is a top view of an air trap reservoir according to various embodiments, arranged in fluid communication with a sample-containment feature.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only, and are intended to provide even further explanation of various embodiments of the present teachings.